CHAPTER V - APPLIED TROPICAL CYCLONE RESEARCH SUMMARY

1. JTWC RESEARCH

The JTWC mission includes the definition and conduct of applied technique development as time and resources permit. The goal of JTWC's effort is to improve the timeliness and accuracy of operational tropical cyclone warnings. During 1981, JTWC continued to pursue projects of operational and technical merit as summarized in the following abstracts of works in progress:

CLIMATOLOGY OF TROPICAL CYCLONES THAT DEVELOP IN THE TRUK AREA

(Allen, J. W., NAVOCEANCOMCEN/JTWC)

A comprehensive review of pertinent parameters conducive to tropical cyclone development in the Truk area is underway. The subsequent path of movement statistics will provide invaluable guidance on the forecasting of tropical cyclones that move out of this region, many of which affect military facilities on Guam.

EVALUATION OF THE BLENDED PERSISTENCE AND CLIMATOLOGY (BPAC) FORECAST AID

(Weir, R. C., NAVOCEANCOMCEN/JTWC)

From September 1980 to December 1981, JTWC utilized the BPAC forecast as one of the many objective forecast aids used to support the warning process. During the 1981 season, BPAC forecasts were verified against the official forecast and nine other objective aids. Although BPAC forecasts by comparison showed good skill in 1981, preliminary results from a detailed evaluation of these forecasts indicate that weighting factors between persistence and climatology, if modified, would have produced a better forecast in most of the investigated cases. Each of the persistence/climatology-type forecast aids is affected by sudden synoptic changes which influence the future cyclone track but have not occurred (persistence) and are not forecast (averaging of historical movements, climatology). However, most of these situations occur near higher latitudes where numerical forecast models can provide the forecaster substantual lead-time to alter the forecast. In the lower latitudes, especially south of 20N, the persistence/climatology-type forecast aids provide excellent guidance in nearly 75 percent of the forecast situations. It is within this region that BPAC offers the promise of providing the best non-synoptic forecast track. The results of this evaluation and details of the BPAC program will be published as a NAVOCEANCOMCEN/JTWC TECH NOTE.

GEOMAGNETIC CORRELATIONS WITH TROPICAL CYCLONE DEVELOPMENT

(Morss, D. A., Cianflone, R. E., Det 1, 1WW, NAVOCEANCOMCEN/JTWC)

A statistical study will be carried out to determine the degree of correlation between geomagnetic disturbances of the earth's atmosphere and the development period of tropical cyclones. No attempt will be made in this study to investigate a cause-effect relationship. The results could be applicable to tropical cyclone forecasters on a worldwide basis, provided they had access to the proper geomagnetic data such as that available through Air Force Global Weather Center, Offutt AFB, Nebraska.

ACCELERATION OF NORTHWARD MOVING TYPHOONS SOUTH OF JAPAN

(Weir, R. C., NAVOCEANCOMCEN/JTWC)

A study of typhoons approaching Japan from the south has resulted in a new forecast aid for use at JTWC. Of the systems that met the initial screening criteria, 90% were seen to have experienced significant accelerations. There was evidence that most of the typhoons nearly triple in speed over the initial 24 hour period. The results are presented for seasonal, and latitudinal, variations in tabular form.

EVALUATION OF THE NAVY NESTED TWO-WAY INTERACTIVE TCM (NTCM) AND THE ONE-WAY INTERACTIVE TCM (OTCM/TCMO)

(Weir, R. C., NAVOCEANCOMCEN/JTWC)

A continuing evaluation of both of these versions of the Navy's tropical cyclone models was conducted during the 1981 season. Initial data have shown the ARQ version of the NTCM (initialized on the 12-hour prognostic fields) is not performing up to expectations. The ARQ and automated versions of the OTCM have performed very well, especially at the 24 and 48 hour periods.

EVALUATION OF THE NAVY GENESIS POTENTIAL PROGRAM

(Allen, J. W., NAVOCEANCOMCEN/JTWC)

The Genesis potential program uses a set of algorithims applied to FNOC analysis fields to predict tropical cyclone formation at the 24, 48 and 72 hr periods. The products are output at 12-hour intervals by FNOC, and received in graphics form by JTWC, covering the entire Northern Hemisphere AOR. Based on the day-to-day evaluation of this product during 1981, its information did not have an impact on the JTWC decision making process for tropical cyclone genesis.

2. NEPRF RESEARCH

TROPICAL CYCLONE RESEARCH AT OR UNDER CONTRACT TO THE NAVAL ENVIRONMENTAL PREDICTION RESEARCH FACILITY (NEPRF), MONTEREY, CALIFORNIA

THE NAVY TWO-WAY INTERACTIVE NESTED TROPICAL CYCLONE MODEL (NTCM)

(Harrison, E. J., Jr., NEPRF)

Testing of the NTCM continued throughout

the 1981 season. Comparison of results obtained when the model was initialized with prognosis vs. analysis data revealed that an unacceptable amount of skill was lost with the prognosis initialization. Unless the new global model prognosis fields are significantly better than the global band data currently used, the NTCM will necessarily be initialized with analysis data in the future.

A second test of the NTCM compared its performance to those of the Movable Fine Mesh Model (MFM) used by the National Hurrican Center in Miami. The favorable results of this comparison led to the NTCM code being requested for further testing and possible operations evaluation by the Hurricane Center.

TROPICAL CYCLONE PREDICTABILITY

(Fiorino, M., Harrison, E. J., Jr., NEPRF)

We have examined the predictability of the Nested Tropical Cyclone Model (NTCM) by comparing two series of 5-day model forecasts in which the initial state has been slightly modified. This initial difference led to random errors in the track forecasts that increase in time. We find that the predictability limits of the NTCM are approximately 105 nm at 24 hours, 152 nm at 48 hours and 200 nm at 72 hours.

THE ROLE OF THE LARGE-SCALE ENVIRONMENT IN DYNAMIC TROPICAL CYCLONE MODEL FORECASTS

(Fiorino, M., NEPRF)

The nested Tropical Cyclone Model (NTCM) has been tested for over 400 cases in the Western Pacific. The FNOC operational analyses used to initialize the NTCM have been archived and will form the data base for this study. The large-scale wind fields will be decomposed into spatial scales using the method of empirical orthogonal functions. The response of NTCM to the scales (principal components) contained in the initial data will be assessed by comparing track forecast "critical" scales of motion as well as model sensitivity to analysis errors.

TROPICAL CYCLONE OBJECTIVE FORECAST CONFIDENCE AND DISPLAY TECHNIQUE

(Tsui, T., NEPRF, Nuttall, K., Systems and Applied Sciences Corp.)

A Functional Description (FD) for the Combined Confidence Rating System has been prepared. Under this system, a scheme has been developed for operational use to evaluate all objective position forecasts of the western North Pacific tropical cyclones. Forecasters at JTWC can issue one combined ARQ request to generate all objective forecasts and their rated confidences/skills. According to the rated confidence of each technique, a combined forecast is constructed. In addition, a standard displaying format for all objective forecasts has been created; and is now being installed on the FNOC operational libraries.

TROPICAL CYCLONE INTENSITY FORECAST

(Tsui, T., Brody, L. R., NEPRF)

The first stage of the western North Pacific tropical cyclone intensity forecast program (MAXWND) is being implemented on the operational system at FNOC. This portion of the program deals with the intensity change due to the persistence change (past 12- and 24-hours) and the climatological influence (the position of the sun relative to the center of the storm). Intensity change information extracted from the satellite IR data and large-scale forecast fields, if warranted, will be added to the program in the future. Wind radius forecast algorithm will also be incorporated in the MAXWND. Along with the intensity forecasts for the western North Pacific tropical cyclones, the 100-, 50-, and 30-kt wind radius forecasts will also be the product of the MAXWND.

SATELLITE BASED TROPICAL CYCLONE INTENSITY FORECASTS

(Brody, L. R., Tsui, T., NEPRF, and Nicholson, F. H., Systems Control Technology)

Currently under development are methods to improve the MAXWND system by using satellite IR data. The NEPRF Satellite-data Processing and Display System is being used for this purpose. Two types of predictors to forecast intensity changes are being investigated. The first type are measures of the coldest equivalent black body temperatures of cloud tops for concentric rings centered on the tropical cyclone. The other type of predictors are derived from the characteristics of the spiral band structure of the tropical cyclone.

TROPICAL CYCLONE SPIRAL LINEARIZATION TECHNIQUE

(Lee, D. H., NEPRF)

A system for quantifying information inherent in the spiral band structure of tropical cyclones as depicted in satellite data has been implemented on the NEPRF Satellite-data Processing and Display System. The Spiral Linearization Technique involves the transformation of a satellite image to a selected spiral coordinate system; cloud structures which conform to the spiral shape are portrayed as linear formations after linearization. Statistical and quantitative analyses of the linearized image yield information on a cyclone's structure which can be correlated with the cyclone's characteristics and behavior. An investigation of these correlations is in progress to determine the technique's potential as an estimator of current and/or future cyclone parameters.

TROPICAL CYCLONE STRIKE AND WIND PROBABILITIES

(Brand, S., NEPRF; Jarrell, J. D., Science Applications, Inc.; Chin, D., Systems and Applied Sciences Corp.)

Tropical cyclone strike and wind probability is a method for determining up through 72-hr that a tropical cyclone will come within or affect geographical points of interest to the user. Applications presently being developed, tested and implemented for the western North Pacific, eastern North Pacific, North Indian Ocean, western North

Atlantic and Gulf of Mexico include: strike/wind probabilities and geographical depictions; optimum track ship routing (OTSR) aids; and HP9845/Tactical Environmental Support System (TESS) software for shipboard environmentalists and decision makers.

TROPICAL CYCLONE STORM SURGE

(Brand, S., NEPRF; Jarrell, J. D., Compton, J., Science Applications Inc.)

A tropical cyclone storm surge effort has been initiated to establish the following: (a) the needs of the Navy in forecasting tropical cyclone storm surge in the western Pacific; (b) the state of the art of storm surge forecasting techniques; and (c) the best approach to solving the Navy's problems associated with tropical cyclone storm surge.

TROPICAL CYCLONE FORMATION FORECAST

(Lowe, P., NEPRF)

The "Genesis" technique is a quasi-objective technique for producing probabalistic forecasts of tropical storm formation in the western North Pacific Ocean. "Genesis" performance has been closely monitored and evaluated. Currently, an effort is being made to modify the "Genesis" technique. The change includes the objectively derived fields of unconditional probabilities replacing the subjective values currently in use. The improved "Genesis" technique is expected to be available early in Calendar Year 1982.

3. PUBLICATIONS

Huntley, J. E., and Diercks, J. W., 1981: The Occurrence of Vertical Tilt in Tropical Cyclones, Monthly Weather Review, Vol. 109, No. 8, Aug 1981, pp. 1689-1700.

Developing tropical cyclone are often observed with significant displacements between their surface and upper-level circulation center. The slope is in the direction of the convective cloud mass which also is displaced from the surface center during the early stage of development. As the cyclone intensifies, the surface and upper-level centers become vertically aligned. Three representative tropical cyclones in the western North Pacific with extensive aircraft reconnaissance are discussed to illustrate this phenomenon.

Dunnavan, G. M., 1981: Forecasting Intense Tropical Cyclones Using 700 mb Equivalent Potential Temperature and Central Sea-Level Pressure, NAVOCEANCOMCEN/JTWC 81-1, TECH NOTE.

Sikora (1976), et al., suggests that the equivalent potential temperature at 700 mb in a developing tropical cyclone is an excellent parameter to measure the total thermodynamic energy such that abnormally high values of equivalent potential temperature ($\geq$ 370K) can herald a period of subsequent explosive deepening. This note expands on that idea to propose a technique for forecasting the development of intense tropical cyclones (minimum sea-level pressure $<$ 925 mb) based on the relationship of the total thermodynamic field, as measured by the tropical cyclone's central 700 mb equivalent potential temperature, and the kinematic field, as measured by the tropical cyclone's central sea-level pressure. One hundread seven tropical cyclones which occurred in the north Western Pacific and north Central Pacific Ocean were evaluated using 700 mb temperature, 500 mb dewpoint and sea-level pressure data which were available from past Annual Typhoon Reports (1975-1980). These data were used to develop a forecast technique whereby the tropical cyclone forecaster may anticipate significant development in a tropical cyclone by monitoring the central sea-level pressure and 700 mb equivalent potential temperature provided by aircraft reconnaissance.

Huntley, J. E., 1981: A Study of Recurving Tropical Cyclones $\geq$ 34 kt (18 m/sec) in the Northwest Pacific 1970-1979, NAVOCEANCOMCEN/JTWC 81-2, TECH NOTE.

Recurving tropical cyclones in the Northwest Pacific region were studied to observe their behavior relative to track and intensity. Tropical cyclones occurring from 1970 through 1979 were selected for this study and categorized into three groups based upon their maximum intensity. Parameters relating to the point of recurvature, direction and speed of movement, and intensity were analyzed. The skill of forecasting speed of movement by a solution to a first order differential equation was investigated.